2 of 3

34 pp [redacted]

Technical Note N-614

POLAR STRUCTURES - DESIGN CONCEPT FOR A HEAVY-EQUIPMENT FIELD REPAIR SHELTER

BY

G. E. Sherwood and E. H. Moser, Jr.

1 July 1964

U. S. NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

POLAR STRUCTURES - DESIGN CONCEPT FOR

A HEAVY-EQUIPMENT FIELD REPAIR SHELTER

Y-F015-11-01-105

Type C

by

G. E. Sherwood

ABSTRACT

Observations during Deep Freeze 61 through 64 showed the need for a field repair shelter for heavy construction and transportation equipment at outlying work centers and construction projects at established polar locations such as McMurdo Station, Antarctica. A review of the requirements showed that the temporary maintenance shelter and the portable maintenance shelter were not suitable because of design and size.

This technical note presents the concept and design of a one/two-stall repair shelter for the maintenance and repair of equipment up to Size 6 snow tractors. A canvas-covered, arch-framed structure with steel members was used for the design. The shop area was located adjacent to the repair areas for convenience and efficiency, and the entire shelter was mounted on skids for portability. The one-stall shelter and its outfitting will cost about $29,000; it will weigh about 30,500 pounds packaged for shipment. This cost is about 10 percent more and the weight is about 30 percent more than the portable maintenance shelter and its shop wanigan. The two-stall shelter and its outfitting will cost about $37,400; it will weigh about 41,400 pounds packaged for shipment. This cost is about 20 percent less and the weight is about 30 percent less than the temporary maintenance shelter.

It is concluded that a prototype of the heavy-equipment field repair shelter should be evaluated at an outlying work center or construction project at an existing polar station.

INTRODUCTION

Two packaged shelters have been developed by the Laboratory for maintenance and repair of transportation and construction equipment in polar regions. A large three-stall shelter was developed for temporary installations; a portable, lightweight, one-stall shelter was developed for airborne operations. Neither satisfy the shelter requirements for equipment repair at outlying work centers and construction projects at established polar stations. The temporary maintenance shelter is not easily moved from site to site and the portable maintenace shelter is too small for much of the heavy equipment at these stations.

This technical note covers the design of a one/two-stall heavy-equipment field repair shelter to support construction and maintenance in outlying facilities at polar stations. The shelter has not been evaluated, but its concept and design, which were developed from field tests with the portable shelter, appears suitable for its intended function. Specifications and drawings are available for its fabrication and outfitting has been selected for its test and evaluation.

BACKGROUND

A 20- by 24-foot portable maintenance shelter[1,2] (Figure 1) was developed by the Laboratory in 1962 for pioneer and airborne operations to isolated polar areas. It was designed around the Size 2 snow tractor[3] which is normally the largest piece of equipment used in these operations. For air transportability, the shelter consisted of an aluminum frame (Figure 2) and a single-thickness, plastic-coated nylon cover; for ground portability, it was mounted on skids. An 8- by 20-foot standard portable camp wanigan[4] was outfitted as a shop for the shelter and a utility service sled[5] was used to energize the electrical tools and fixtures and to heat the shelter.

Prototypes of the portable maintenance shelter and its companion pieces were evaluated at the NCEL Ross Ice Shelf field camp during the summer seasons of Deep Freeze 63 and 64. It was found that the shelter was easy to erect,[6] easy to move and, with the shop and utility sled, it was adequate for maintenance and repair of the snow tractors,[3] snow

mixers,[7] snow planes,[8] snowplows,[9] weasels,[10] and other equipment used in the Laboratory field trials.

REQUIREMENTS

During the summer seasons of Deep Freeze 62, 63, and 64, it was observed that the outlying facilities around McMurdo Station - Old Williams Field, New Williams Field, and the sea ice harbors - required heavy equipment up to Size 6 snow tractors for their construction, maintenance, and repair. Reports also showed that similar equipment was used to construct the ice runway at New Williams Field during the winter of Deep Freeze 62-63.

New Williams Field, which is located about 5 miles from McMurdo, is the principal airfield for Antarctica. During the summer of Deep Freeze 64, it was observed that numerous pieces of heavy construction equipment were used to maintain and repair the ice runway, the snow skiway, the snow and ice aircraft parking areas, and the snow roads in the 300-man summer camp. Also, tractor-towed sled trains were used to move cargo into and around the field.

New Williams Field is located on ice covered with 3 to 5 feet of snow, so only lightweight, easily moved structures can be used for the summer camp and other buildings in the area. Since no lightweight portable shelter of adequate size is available for repair of the equipment used at the field, it is hauled to a centralized repair facility in McMurdo for all but minor maintenance. During the summer of Deep Freeze 64, it was observed that this not only prolonged the equipment down-time, but also required extensive cleaning of the equipment after repair. This was necessary to remove dirt and mud that collected on the equipment while it was in the McMurdo area. Otherwise, it would drop off and deteriorate the operational snow and ice areas.

Except for major overhauls, on-the-job repairs at New Williams Field would have permitted better utilization of the equipment assigned to that area. Centralized repair because of inadequate facilities for field repair is not unique to McMurdo. Similar situations exist at other established polar stations.

Concept

Canvas-covered arch-rib construction similar to that used in the portable maintenance shelter[1] was selected for the heavy-equipment field repair shelter. To reduce the cost of the shelter, steel rather

than aluminum was to be used for the ribs and other structural parts. The weight of the frame was not considered critical since the shelter would be used principally at established locations. It was to be skid-mounted for limited ground portability. The repair stalls were to be sized for easy repair of Size 6 snow tractors and the shop area, included for convenice and efficiency, was to be large enough to house the maintenance and repair machinery and tools. A traveling hoist was to be provided for removing tractor engines and other heavy parts. The hoist was also to be used for removing cabs from the equipment, so it had to be high enough to perform this task.

One repair stall and a shop area were to be included in the basic, or one-stall, shelter (Figure 3). The expanded, or two-stall, shelter was to have a second repair area attached to the shop end of the shelter. A fixed floor was to be provided for the shop, but pallet-type flooring was to be used for the repair stalls.

A single-thickness, canvas-type material was to be used for the cover. This less expensive cover was selected instead of an insulated cover since the shelter would be used principally during summer operations. The structural frame was to be designed so that an insulated cover similar to the one on the Jamesway[11] could be developed for the shelter in the event its use in winter operations warranted this expense.

Shop machinery, workbenches, storage cabinets, and hand tools were to be provided for the general maintenance and repair of heavy equipment. Also, an oil-fired, forced-air heater was to be provided for the shop area. Both the basic shelter and the second repair stall were to be fitted with electrical harnesses, but no power supply was to be provided with the shelter.

CRITERIA

General criteria applicable to all structures for pioneer polar camps was used in designing the heavy-duty field repair shelter:

1. Satisfactory operation in ambient temperatures to -65 F.

2. Structural adequacy for winds up to 100 miles per hour.

3. Simplicity of design.

4. Minimum maintenance requirements.

5. Maximum use of Federal standard stock items or readily available commercial items.

6. Fast and efficient assembly or erection.

Special criteria for the design were:

1. A basic shelter with one repair stall and a shop area expandable to a two-stall shelter.

2. Repair areas for Size 6 snow tractors with 4-foot work spaces on each side and 3-foot work spaces at each end.

3. A floored shop area of at least 300 square feet.

4. A frame of knock-down steel construction.

5. A cover of single-thickness canvas or similar material.

6. Curtain-type closures for the equipment entries to the repair areas.

7. A personnel door in the shop area.

8. A hoist with a lifting capacity of 4 tons and sufficient height to remove the cab from a Size 6 snow tractor.

9. An electrical harness for general lighting and for energizing electrically-driven power tools.

10. Heat for the shop area.

11. Selection of machines and tools for the shop.

SHELTER DESIGN

The basic shelter is 28 feet wide by 44 feet long by 16 feet high (Figure 4). A 28- by 32-foot area at one end serves as an equipment repair stall; a 12- by 28-foot floored area at the other end serves as a shop. The shelter length can be expanded in 8-foot increments on the shop end to form a second 28- by 32-foot repair stall. This results in a two-stall shelter with the shop at the center.

Reduced copies of the drawings for the shelter are shown in the Appendix. Full size prints of these drawings are available from NCEL.

Specifications for the shelter are contained in Laboratory Technical Note N-615, "Polar Structures - Specifications and Outfitting for a Heavy-Equipment Field Repair Shelter" (Reference 12).

Frame

The shelter frame is all steel. Arch ribs are supported on skids along both longitudinal edges of the structure. The ribs are spaced by purlins in each bay and braced by cross-bracing in the end bays and the center bay. The endwalls have no framing except removable struts which provide horizontal support for the end covers.

The skid sections are 2 feet wide and 8 feet long. Sections are bolted end to end to achieve the desired length. A 9-inch-wide portion of the skid is left unobstructed to provide a track for the traveling hoist.

The arch ribs consist of two 6-inch steel columns 16 feet 3 inches long and an arch made up of two 5-inch tees with the stems welded together to form a 10-inch I beam. The tees are rolled to a 32-foot radius before they are welded together. The haunch of the arch is rolled to a 2-foot 6-inch radius, and the stems of the tees are tapered to form a 6-inch web where the arch connects to the column. The connection is made by two plates which are welded to each side of the web of the arch and bolted to the web of the column. The base of each column is bolted to a skid. Ribs are spaced 4 feet on centers through the length of the shelter.

Purlins made from 1-1/2-inch tees fit into clips which are welded to the web of ribs. Skirt panels, 15 inches high by 4 feet wide, bolt to the column flanges at the base of the columns. Clips are provided on the skirt panels for tying down the ends of the roof covers.

Cross-bracing in the end bays and the center bay is provided by turnbuckle rods which bolt to the column flanges. The turnbuckles are tightened after the rods are bolted in place.

Removable struts span between the columns at the third points of the column height in the endwalls. These struts rest on clips. They can be bolted to the clips or left unbolted if the struts are to be removed often to admit equipment.

Cover

The cover for the maintenance shelter is a single thickness of

plastic-coated nylon. Roof covers are wide enough for one 4-foot bay with 1-foot 2-inch overlap. Straps are provided on the inner face of all covers for tying them to the frame. Belly bands are placed over each rib to further secure the covers. The ends of the belly bands and the roof covers are secured to the skirt panels with hook buckles.

The end covers consist of three parts. Right and left curtains slide horizontally on cables to provide a large opening for equipment. The space above the curtains is closed with a gable cover. The curtains are fastened with harness snaps to cables stretched across the ends of the shelter at the base and at the top of the columns. Right and left curtains slide on separate sets of cables and overlap about 2 feet at the center. The cables are tightened with turnbuckles. The turnbuckles on the lower cables must be loosened for equipment to drive over the cables.

Shop Floor

The 12- by 28-foot shop area is floored with 1-1/8-inch tongue and groove plywood panels. The floor panels are supported by 10-inch I beams which span the width of the shelter at 4-foot spacing and are supported at each end on the skids. The beams have 2 by 6 wood nailers bolted to the top of them for securing the panels with wood screws. The plywood floor panels are either 4 by 8 feet or 4 by 4 feet, depending on whether they span one or two bays.

Traveling Hoist

The 4-ton-capacity hoist travels laterally across the shelter on a steel I beam. The I beam is supported at each end by adjustable A frames mounted on wheels which travel in tracks on the shelter skids. The width of the skids distributes this load over a large bearing area.

Personnel Door

A panel fitted with a 1-inch-thick plywood door is used for personnel entry to the shop area. The door panel can be bolted to the column flanges in any bay of the frame. The skirt panel is removed and the shelter cover is cut off just below the top of the door panel.

Electrical Harness

The electrical harness provides a 120-volt duplex outlet and a 240-volt twist-lock outlet at 8-foot intervals along each sidewall of the repair stalls. In the shop area, the outlets are spaced on 4-foot

centers. Light fixtures on cords are provided at each outlet in the repair stalls. These fixtures, which plug into the outlets, are provided with hooks for hanging them at any point along an arch rib. Light fixtures in the shop area are mounted in fixed positions.

SHOP OUTFITTING

A 280,000 to 392,000 Btuh, oil-fired, forced-air heater was selected to heat the shop area and take the chill off the repair stalls. The heater is mounted overhead to prevent its vent from interferring with movement of the traveling hoist (Figure 5).

The shop machinery and tools were selected to provide for general maintenance and repair of gasoline and diesel-driven transportation and construction equipment at outlying sites around an established polar station. Operational experience in Deep Freeze[13,14] and Laboratory field experience with the portable maintenance shelter[1] and temporary maintenance shelter[15] were used to develop the outfitting for the field repair shelter. Four general classes of machinery and tools were selected: fixed shop machines, portable shop tools, general shop tools, and mechanic hand tools. Also, an exhaust fan was provided for the shop area and exhaust hoses were provided for equipment under repair (Figure 4). A detail list of the outfitting is given in Laboratory Technical Note N-614, "Polar Structures - Specifications and Outfitting for a Heavy-Equipment Field Repair Shelter" (Reference 12).

A layout of the shop area is shown in Figure 6. In this layout, the machinery, workbenches, storage bins, and tool chests are arranged for convenience of the repair stall in the basic shelter. Even so, it is fairly convenient for both repair stalls in the expanded shelter.

ESTIMATED WEIGHTS AND COSTS

The estimated shipping weight and cost of the components for the heavy-equipment field repair shelter are given in Table I. The shipping weight of the basic shelter is 20,000 pounds and the cost is $18,000. The shipping weight of the second repair stall is 10,900 pounds and the cost is $8400. The total shipping weight of a two-stall shelter is 30,900 pounds and the total cost is $26,400.

The estimated shipping weight and cost of the outfitting for the shelter is given in Table II. The shipping weight of the outfitting,

including the shop heater, is 10,500 pounds; the cost is $11,000. With the outfitting, a one-stall shelter packaged for shipment will weigh about 30,500 pounds and cost about $29,000; a two-stall shelter will weigh about 41,400 pounds and cost about $37,400.

In comparison, a portable maintenance shelter and its shop wanigan[1] costs $26,848 and weighs 31,328 pounds packaged for shipment. A temporary maintenance shelter and its outfitting[15] costs $45,000 and weighs 70,000 pounds packaged for shipment.

SUMMARY

The heavy-equipment field repair shelter provides a suitable maintenance and repair facility for outlying work centers and construction projects at established polar regions. Its size is adequate for the heavy construction equipment common to such stations and its outfitting is suitable for all types of repairs to this equipment except major overhauls. Availability of a one- or two-stall shelter permits flexibility of selection or expansion for specific work conditions not possible in fixed-size shelters.

The steel frame, the traveling hoist, and the heater for the shelter require a gin pole or a piece of lifting equipment for erection; all other parts can be erected by hand. Once erected, the one-stall shelter can be towed between work areas provided the terrain is relatively flat and level and the traveling hoist and shop outfitting is secured. As the shelter was designed principally for summer operations, a single-thickness material was selected for the cover. For extensive winter operations, it would be necessary to develop an insulated Jamesway-type cover for the shelter.

The one-stall shelter and its outfitting costs less than 10 percent more than the portable maintenance shelter and its shop wanigan. For this relatively small increase, it provides a repair stall for equipment up to Size 6 snow tractors and a common shop and repair area. These two improvements make it suitable for use at diversified work centers around an established polar station. Its 30 percent greater weight makes it less attractive than the portable maintenance shelter for airborne polar operations.

The two-stall shelter and its outfitting costs 20 percent less and weighs 30 percent less than the temporary maintenance shelter and its outfitting. This reduction in cost and weight, coupled with

easier erection and relocation, makes the field repair shelter more suitable than the temporary maintenance shelter for large repair facilities at transient work centers and construction projects around an established polar station.

CONCLUSION

A prototype of the one-stall heavy-equipment field repair shelter should be evaluated at an outlying work center or construction project at an established polar station.

REFERENCES

1. U. S. Naval Civil Engineering Laboratory. Technical Report R-317: Pioneer polar structures - Portable maintenance shelter, by G. E. Sherwood. Port Hueneme, Calif., 23 June 1964.

2. U. S. Naval Civil Engineering Laboratory. Technical Note N-602: Pioneer polar structures - Specifications and outfitting for the portable maintenance shelter, by G. E. Sherwood. Port Hueneme, Calif., 4 June 1964.

3. U. S. Naval Civil Engineering Laboratory. Technical Report R-299: Polar construction equipment - LGP D4 Series C snow tractor, by Douglas Taylor. Port Hueneme, Calif., 6 April 1964.

4. U. S. Naval Civil Engineering Laboratory. Technical Report R-309: Polar structures - The NCEL family of wanigans, by J. E. Dykins, G. E. Sherwood and C. R. Hoffman. Port Hueneme, Calif., 9 June 1964.

5. U. S. Naval Civil Engineering Laboratory. Technical Report R-276: Polar construction equipment - Utility service sled, by S. E. Gifford. Port Hueneme, Calif., 8 November 1963.

6. U. S. Naval Civil Engineering Laboratory. Technical Note N-587: Pioneer polar structures - Erection of portable maintenance shelter, by R. W. Hansen and G. E. Sherwood. Port Hueneme, Calif., 26 May 1964.

7. U. S. Naval Civil Engineering Laboratory. Technical Report R-108: Snow-compaction equipment - Snow mixers, by R. C. Coffin, Jr. and E. H. Moser, Jr. Port Hueneme, Calif., 19 January 1961.

8. U. S. Naval Civil Engineering Laboratory. Technical Report R-110: Snow-compaction equipment - Snow planes, by E. H. Moser, Jr. Port Hueneme, Calif., 9 February 1961.

9. U. S. Naval Civil Engineering Laboratory. Technical Note N-610: Snow transport equipment - Tractor-mounted snowplow tests, by Robert W. Hansen. Port Hueneme, Calif., 29 June 1964.

10. U. S. Naval Civil Engineering Laboratory. Technical Note N-569: Specifications for the M-29 cargo carrier pickup, by N. E. Pierce. Port Hueneme, Calif., 20 January 1964.

11. U. S. Naval Civil Engineering Laboratory. Technical Report R-241: Pioneer polar structures - Accessories for the Jamesway shelter, by G. E. Sherwood. Port Hueneme, Calif., 28 May 1963.

12. U. S. Naval Civil Engineering Laboratory. Technical Note N-615: Polar structures - Specifications and outfitting for a heavy-equipment field repair shelter, by G. E. Sherwood. Port Hueneme, Calif., 1 July 1964.

13. U. S. Naval Civil Engineering Laboratory. Technical Report R-155: Technical data from Deep Freeze I, II, and III reports (1955 to 1958), compiled by R. C. Coffin, Jr. Port Hueneme, Calif., 24 April 1961.

14. U. S. Naval Civil Engineering Laboratory. Technical Report R-210: Technical data from Deep Freeze IV and 60 reports, compiled by R. C. Coffin, Jr. Port Hueneme, Calif., 13 December 1962.

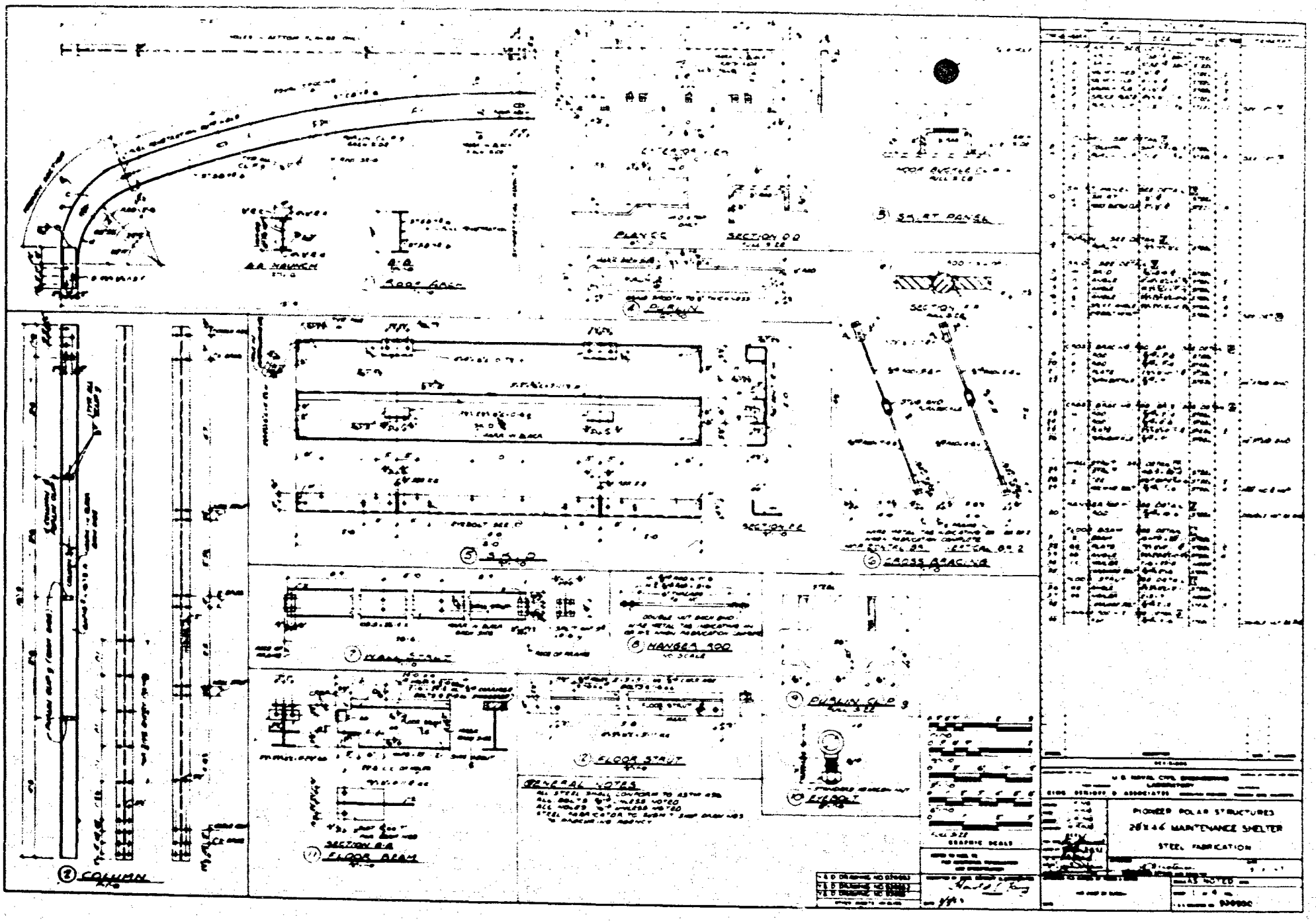
15. U. S. Naval Civil Engineering Laboratory. Technical Report R-265: Temporary polar structures - Maintenance shelter, by J. B. Camm. Port Hueneme, Calif., 26 November 1963.

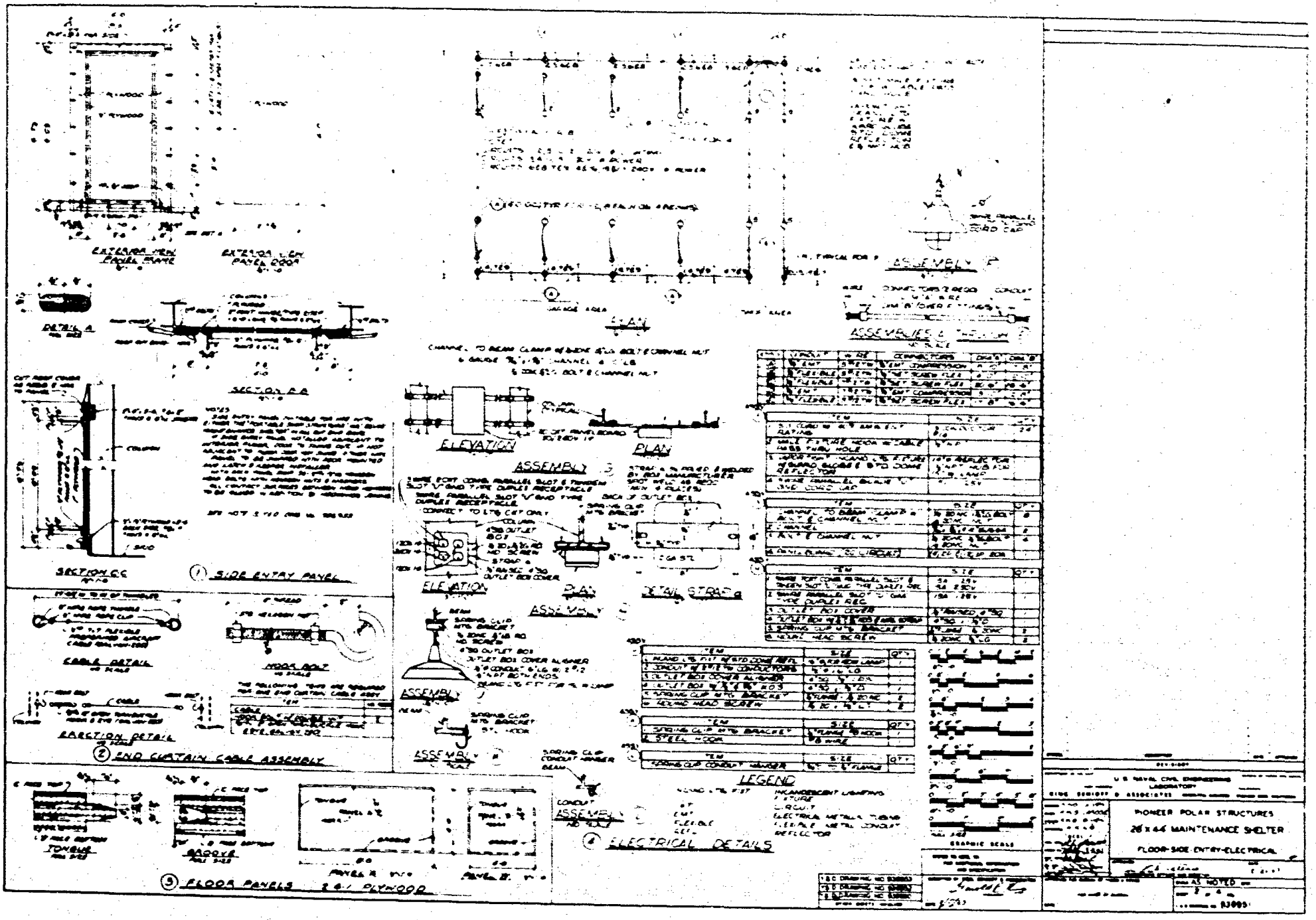
Appendix

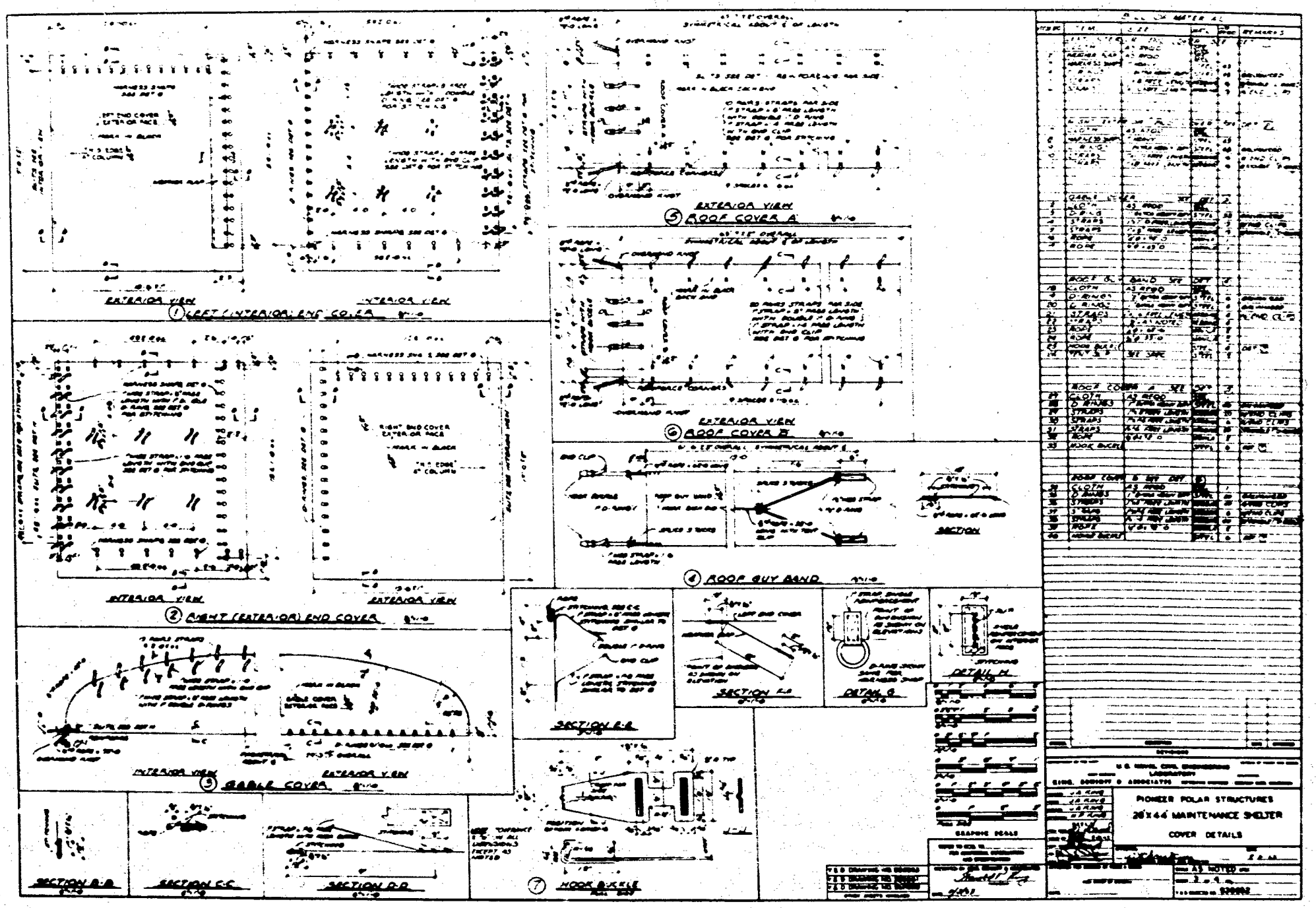
DRAWINGS FOR THE HEAVY-EQUIPMENT FIELD REPAIR SHELTER

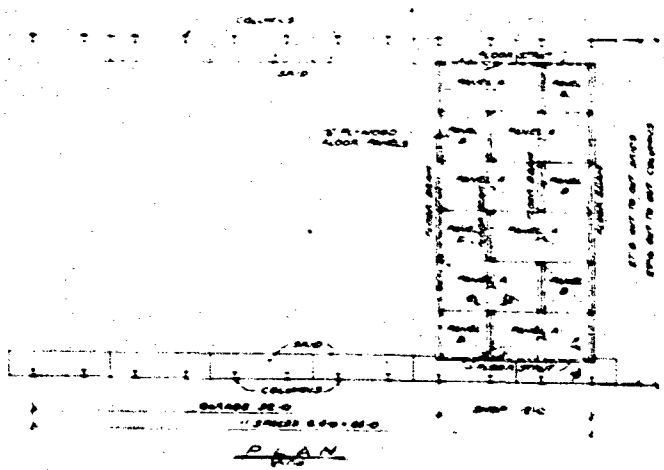
The original of the drawings listed below and shown at reduced scale are available at the Naval Civil Engineering Laboratory, Port Hueneme, California. All drawings are 28 by 40 inches.

Y&D Drawing No.	Title
936950	28- by 44-Foot Maintenance Shelter Steel Fabrication
936951	28- by 44-Foot Maintenance Shelter Floor - Side Entry - Electrical
936952	28- by 44-Foot Maintenance Shelter Cover Details
936953	28- by 44-Foot Maintenance Shelter Erection

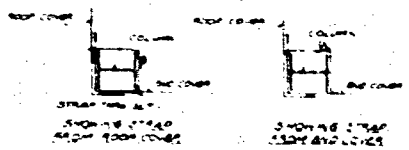

PLAN
SECTION D-D
SECTION E-E
SECTION F-F
SECTION G-G
SECTION B-B
GENERAL NOTES
PIONEER POLAR STRUCTURES
28'x 46' MAINTENANCE SHELTER
STEEL FABRICATION


PLAN
ELEVATION
SECTION A-A
SECTION C-C
1 SIDE ENTRY PANEL
CABLE DETAIL
HOOK BOLT
ERECTION DETAIL
2 END CURTAIN CABLE ASSEMBLY
ASSEMBLY
ASSEMBLY
ASSEMBLY
ASSEMBLY
ASSEMBLY
DETAIL STRAP
LEGEND
4 ELECTRICAL DETAILS
TONGUE
GROOVE
3 FLOOR PANELS 3/4" PLYWOOD
U.S. NAVAL CIVIL ENGINEERING LABORATORY
PIONEER POLAR STRUCTURES
28'x 44' MAINTENANCE SHELTER
FLOOR-SIDE ENTRY-ELECTRICAL
AS NOTED

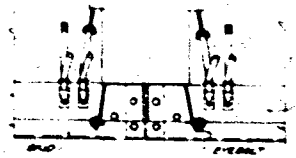

EXTERIOR VIEW
EXTERIOR VIEW
1 LEFT (INTERIOR) END COVER
EXTERIOR VIEW
EXTERIOR VIEW
2 RIGHT (EXTERIOR) END COVER
EXTERIOR VIEW
EXTERIOR VIEW
3 GABLE COVER
EXTERIOR VIEW
5 ROOF COVER A
EXTERIOR VIEW
6 ROOF COVER B
4 ROOF GUY BAND
SECTION
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
DETAIL G
DETAIL H
7 HOOK & EYE
WEAPONS DEALS
U.S. NAVAL CIVIL ENGINEERING LABORATORY
CIVIL ENGINEERING ASSOCIATES
PIONEER POLAR STRUCTURES
20'x44' MAINTENANCE SHELTER
COVER DETAILS
AS NOTED



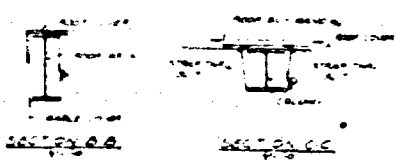
PLAN



SECTION A-A

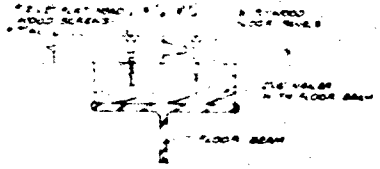


DETAIL 2

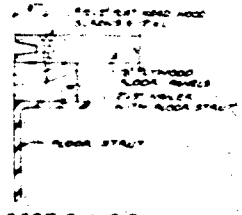


SECTION B-B

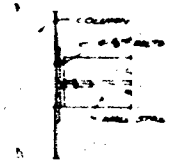
SECTION C-C



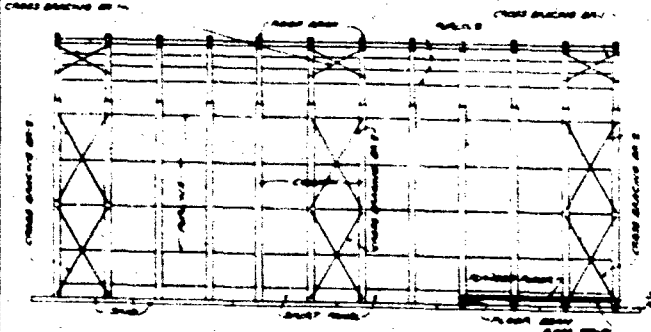
SECTION E-E



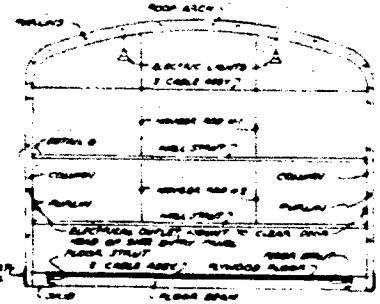
SECTION F-F



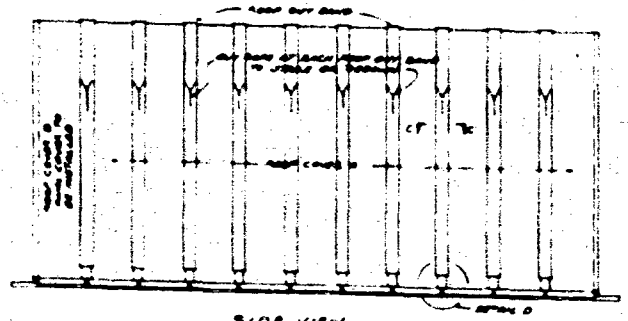
DETAIL G



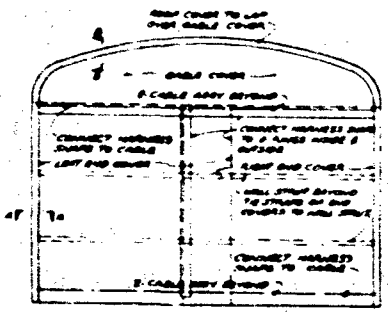
LONGITUDINAL SECTION



TRANSVERSE SECTION

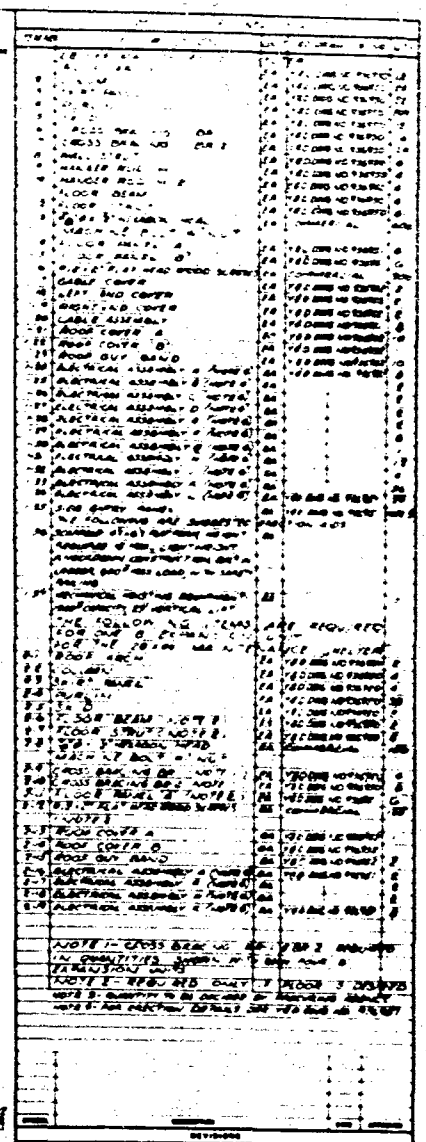


SIDE VIEW



END VIEW

GRAPHIC SCALE



U.S. NAVAL CIVIL ENGINEERING LABORATORY

KING, SUMROFF & ASSOCIATES

PIONEER POLAR STRUCTURES

28'X 44' MAINTENANCE SHELTER

ERECTION

AS NOTED

Table I. Estimated Shipping Weight and Cost of the Shelter Components

Component	Shipping Weight (lbs)	Cost
Basic Shelter		
Frame	15,100	$ 9,600
Material - $3,200		
Labor - 6,400		
Cover (Fabricated)	800	3,200
Shop Floor	2,800	2,400
Material - $ 900		
Labor - 1,500		
Traveling Hoist (Fabricated)	900	2,000
Electrical Harness	400	800
Material - $500		
Labor - 300		
Estimated Total Weight and Cost of Basic Shelter	20,000	$18,000
32-Foot Extension		
Frame	10,200	$ 6,400
Material - $2,100		
Labor - 4,300		
Cover	500	1,600
Electrical Harness	200	400
Material - $250		
Labor - 150		
Estimated Total Weight and Cost of Extension	10,900	$ 8,400
Estimated Total Weight and Cost of Basic Shelter and Extension	30,900	$26,400

Table II. Estimated Shipping Weight and Cost of the Shelter Outfitting

Component	Shipping Weight (lbs)	Cost
Shop Heater	1,000	$ 1,000
Shop Equipment	6,500	6,000
Tools	3,000	4,000
Totals	10,500	$11,000

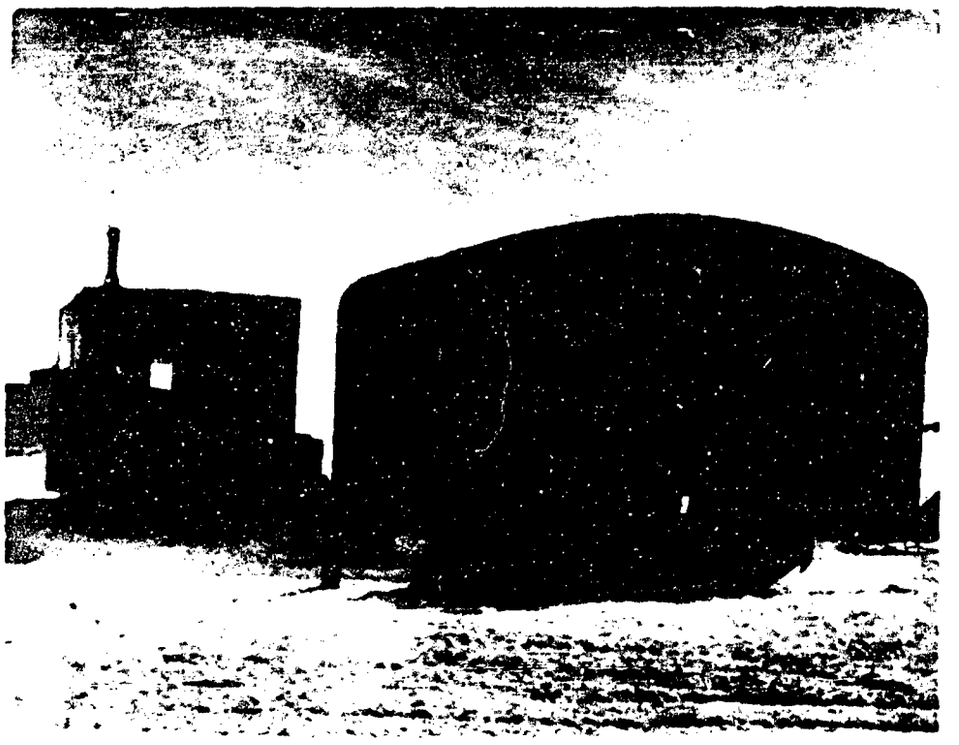


Figure 1. The equipment repair wanigan, the portable maintenance shelter and the utility service sled.

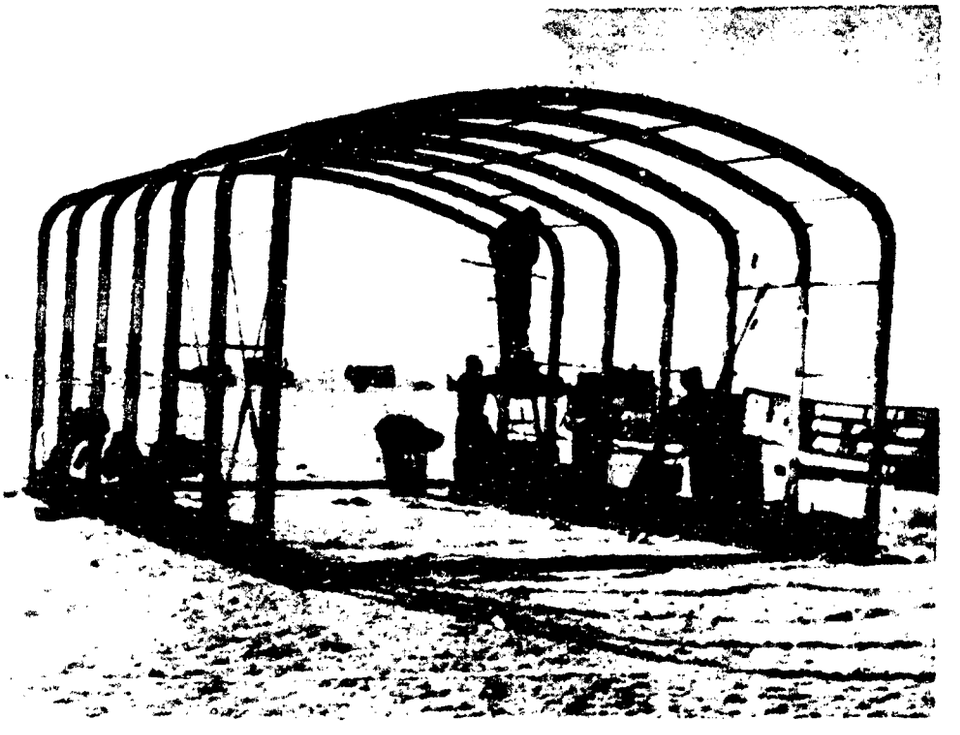


Figure 2. Aluminum frame for the portable maintenance shelter.

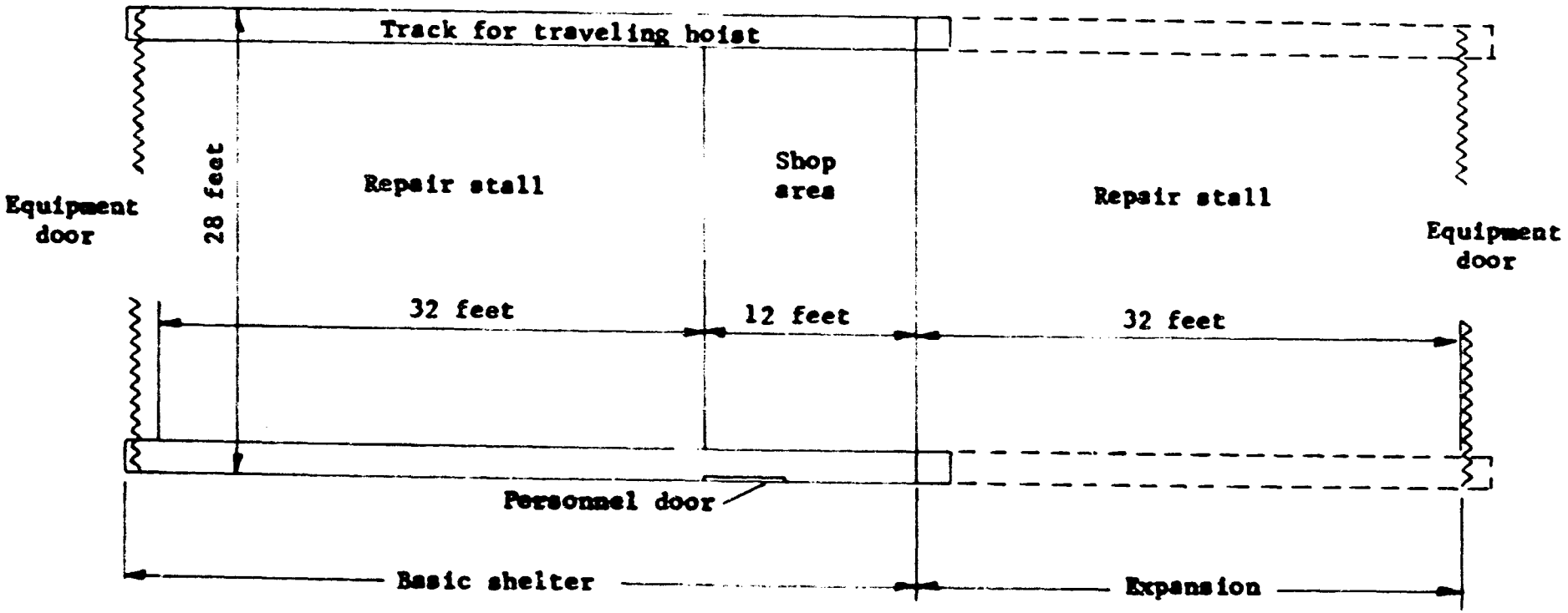


Figure 3. Layout of the heavy-equipment field repair shelter.

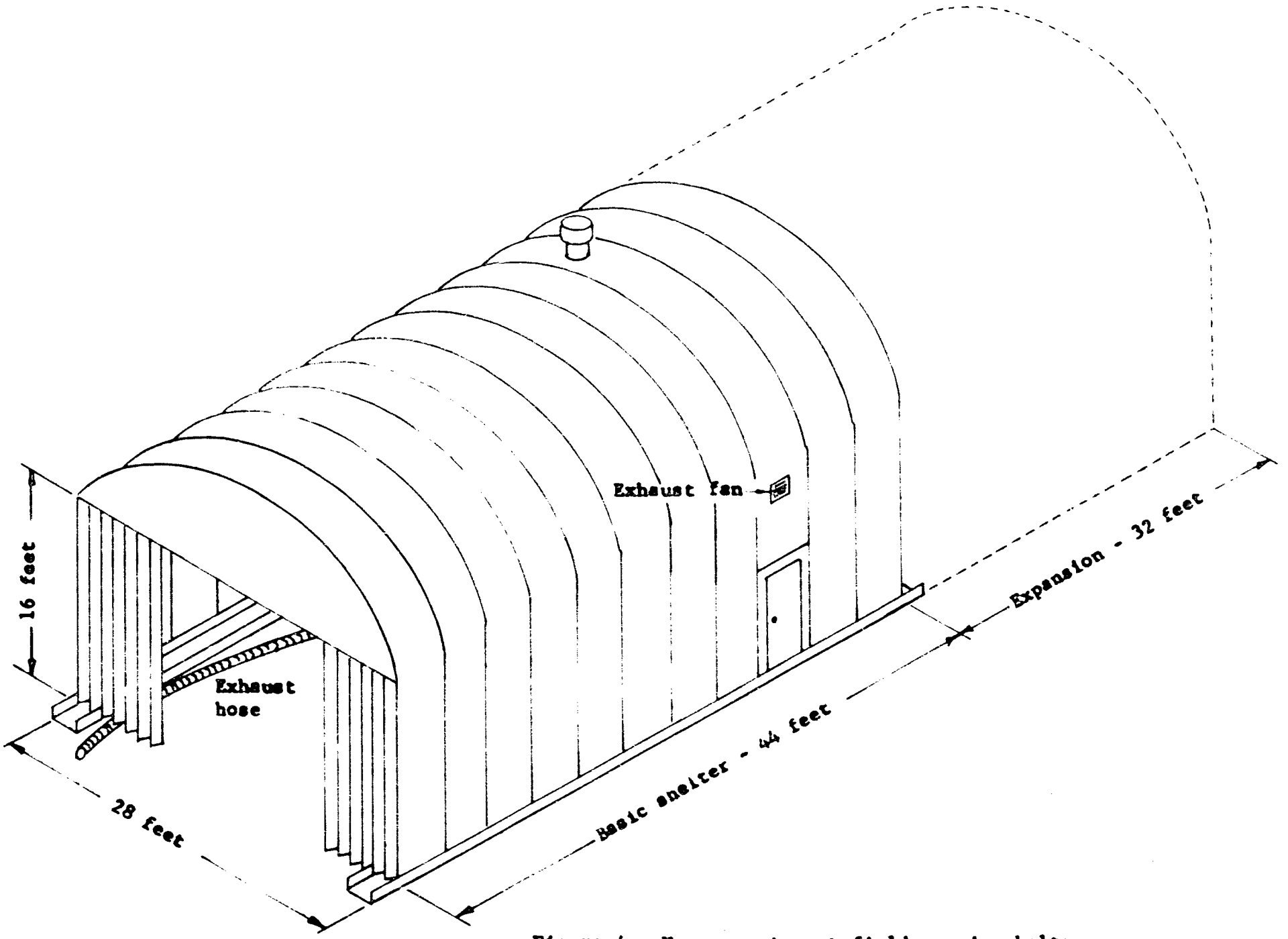


Figure 4. Heavy-equipment field repair shelter.

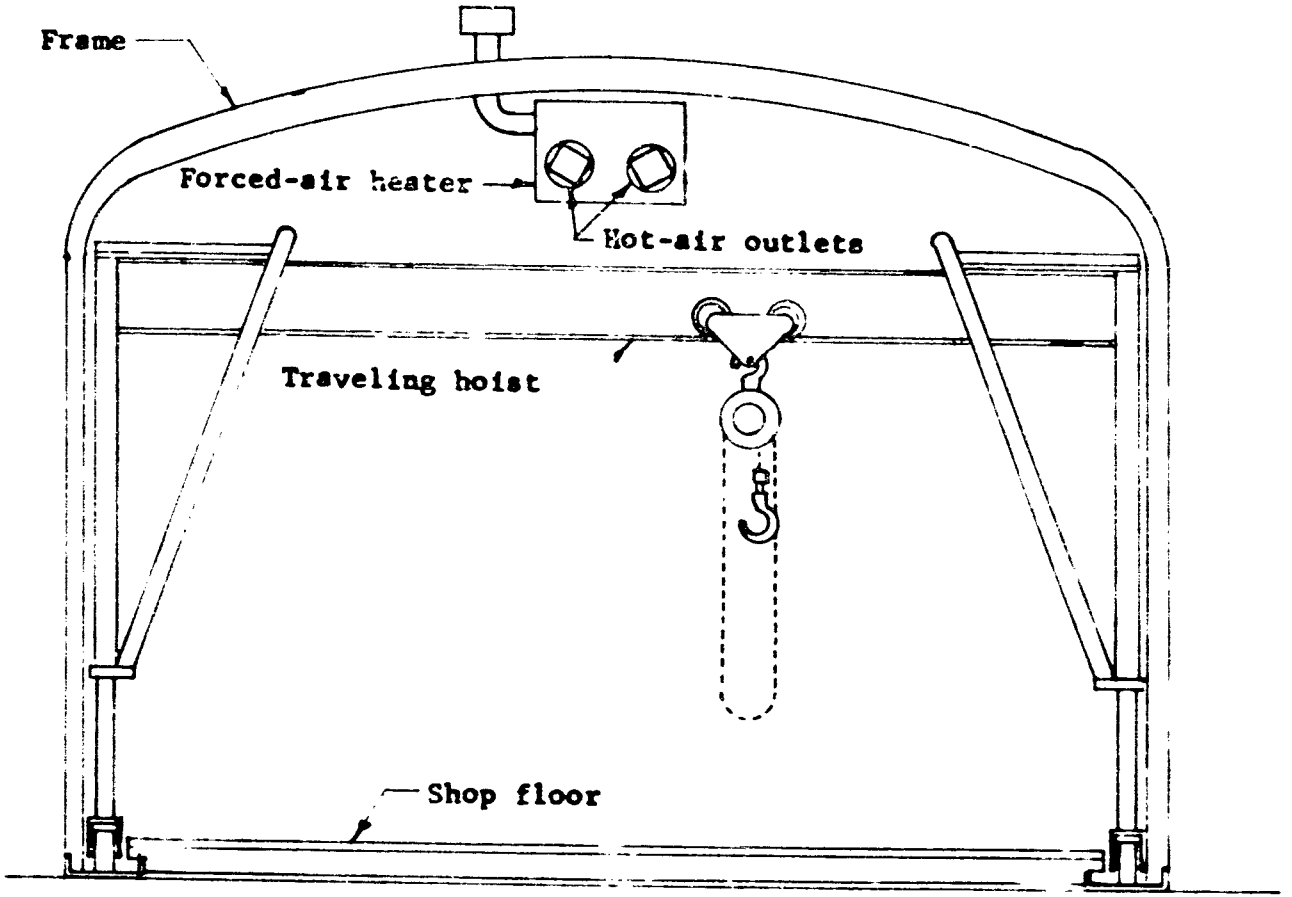


Figure 5. Cross section of heavy-equipment repair shelter.

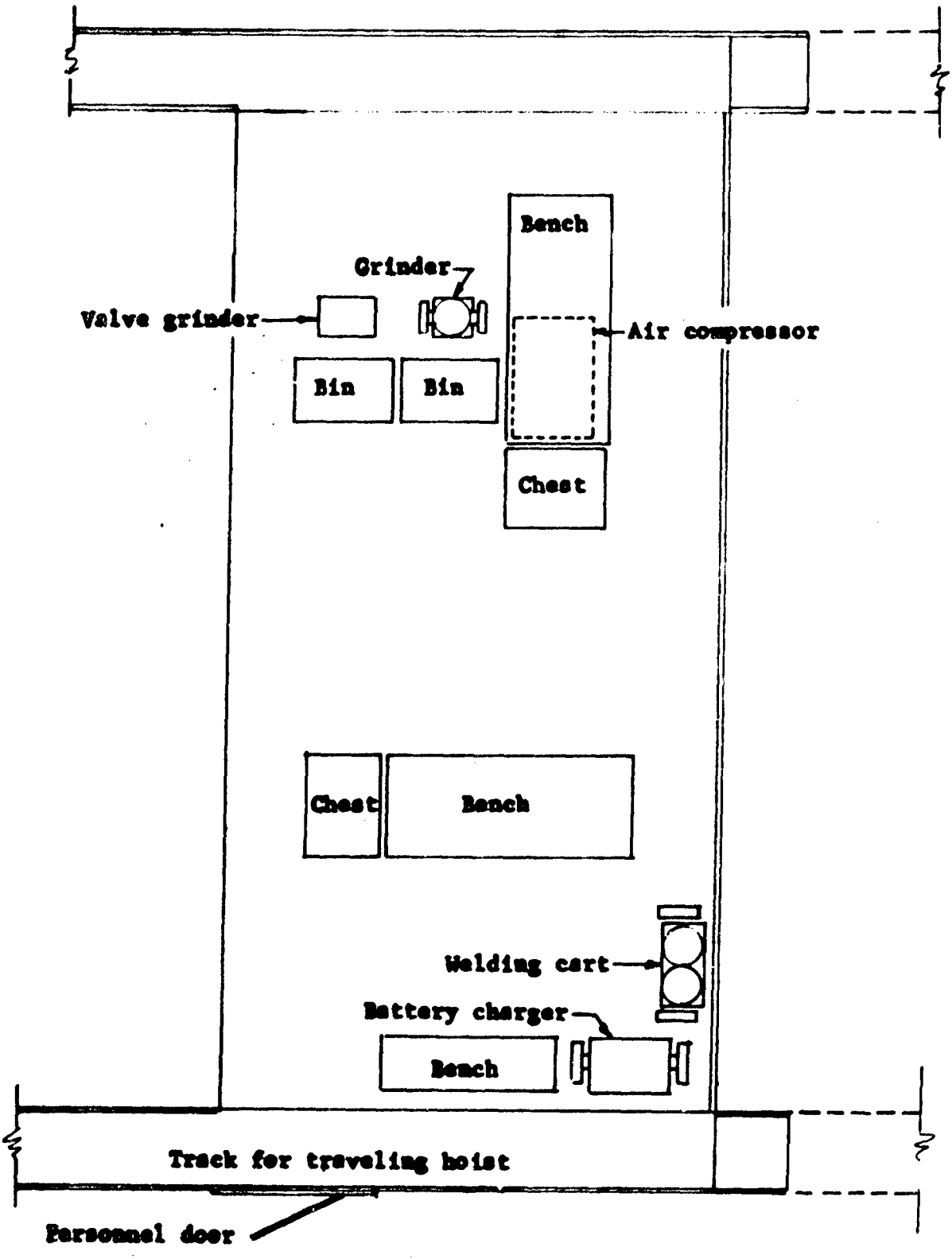


Figure 6. Shop layout in heavy-equipment repair shelter.